1. A circuit, realizing a driver device for secure and reliable firing of an igniter or squib, connecting said squib via a high-side electronic switch to a power source and via a low-side electronic switch to circuit ground, incorporating separate power supply parts for high voltage and low voltage domains and equipped with intrinsic diagnostic and online testing features for circuit protection and operation securing purposes, comprising:

a means for control of said firing, said diagnostic and said online testing;

a means for said high-side switching of said squib to said power source;

a means for said low-side switching of said squib to said circuit ground;

a means for said high voltage domain power supply;

a means for said low voltage domain power supply;

a means for secured supply of electrical energy to said means for said high-side switching derived from said high voltage domain;

a means for secured supply of electrical energy to said means for said low-side switching derived from said low voltage domain;

a means for driving said high-side switching means for said squib controlled by said means for control of firing, diagnostic and online testing and supplying drive current to said high-side switching means either for the case of said diagnostic and online testing operations or for the case of said firing operation; and

a means for connecting said high-side switching means and said low-side switching means to said means for control of firing, diagnostic and online testing in order to execute said diagnostic measurement and online testing whereby in said

case of diagnostic and online testing operations a switchable and controllable current flow is initiated in conjunction with appropriate voltage measurements and resistance evaluations thereby strictly observing that no firing condition for said squib are allowed to occur and whereby in said case of firing operation a secure firing of said squib is always guaranteed.

2. The circuit according to claim **1** wherein said means for said high-side switching of said squib to said power source connects to one side of said squib and said means for said low-side switching of said squib to said circuit ground connects to the other side of said squib, thus forming a switchable squib firing branch between said power source and said circuit ground.

3. The circuit according to claim **1** wherein said means for control of said firing, said diagnostic and said online testing is subdivided into a means for control of said firing and a means for said diagnostic and online testing.

4. The circuit according to claim **1** wherein said means for said high-side switching of said squib to said power source is realized as a controllable electronic switch.

5. The circuit according to claim **4** wherein said controllable electronic switch is implemented using a Field Effect Transistor (FET).

6. The circuit according to claim **5** wherein said FET is of the NMOS type manufactured in CMOS technology.

7. The circuit according to claim **1** wherein said means for said low-side switching of said squib to said circuit ground is implemented using a controllable electronic switch in current mirror configuration.

8. The circuit according to claim **7** wherein said current mirror configuration consists of two FETs.

9. The circuit according to claim **8** wherein said FETs are of the NMOS type manufactured in CMOS technology.

10. The circuit according to claim **1** wherein said means for said high voltage domain power supply include generators and batteries from a vehicle e.g. as primary source (e.g. with voltage range of 15 V to 40V), and derived therein from separate secondary power sources implemented as charge pump devices operating in the same voltage range as said primary source.

11. The circuit according to claim **10** wherein said means for said high voltage domain power supply also includes a controlled current source for said high-side switching device.

12. The circuit according to claim **1** wherein said means for said low voltage domain power supply consist of separate power sources derived from generators and batteries from a vehicle e.g. as primary source (e.g. with voltage range of 15 V to 40V) and operating within a reduced low voltage range (e.g. in the range of 3.5 V to 5V).

13. The circuit according to claim **12** wherein said means for low voltage domain power supply also include controlled current sources for said low-side switching device.

14. The circuit according to claim **1** wherein said means for secured supply of electrical energy to said means for said high-side switching derived from said high voltage domain consists of a charge pump feeding a controlled current source.

15. The circuit according to claim **1** wherein said means for secured supply of electrical energy to said low-side switching means derived from said low voltage domain consists of two controlled current sources fed by voltages out of said low voltage domain for switching between different currents for current limiting and diagnostic testing purposes respectively.

16. The circuit according to claim **1** wherein said means for driving said high-side switching means for said squib consists of an integrated High Side Driver (HSD) circuit implemented in CMOS technology.

17. The circuit according to claim **16** wherein said integrated High Side Driver (HSD) circuit comprises multiple FET transistors of NMOS type, multiple FET transistors of PMOS type, a digital inverter circuit for an input signal fed in from said means for control of said firing, diagnostic and online testing, a current source, and some additional integrated resistors, and whereby external connection pins are used by said input signal, and for connections to supply voltages and GND and for another two output connections for the internally generated driving and sensing node signals connecting to said high-side switching means.

18. The circuit according to claim **1** wherein said means for connecting said high-side switching means and said low-side switching means to said means for control of firing, diagnostic and online testing comprises on one hand output control signal lines leading to said means for driving said high-side switching means and leading to said means for secured supply of electrical energy to said means for said low-side switching derived from said low voltage domain and on the other hand input measurement signal lines from said high-side switching means of said squib and from said low-side switching means, as well as power supply and ground connections.

19. The circuit according to claim **1** whereby into said means for said high-side switching of said squib to said power source are combined together: firstly said switching transistor function for controlled firing operation and for onsite test

diagnostics, secondly said controlled firing operation with current limitation and thirdly said onsite test diagnostics.

20. The circuit according to claim **1** whereby into said means for said low-side switching of said squib to said circuit ground are combined together: firstly said switching transistor function for controlled firing operation and for onsite test diagnostics, secondly said controlled firing operation with current limitation and thirdly said onsite test diagnostics.

21. A circuit, included in a driver device for squibs, containing a control and test unit as well as low-side and high-side electronic FET switches, and operating therein as High Side Driver (HSD) device with integrated sensing capabilities for driving the high-side electronic FET switch, comprising:

one input terminal pin for the input signal, fed in from said control and test unit and internally connected to a digital inverter circuit for generating a pair of antiphased input signals, used internally;

one terminal pin for circuit supply voltage;

one terminal pin for circuit ground;

one input terminal pin for an external bias voltage;

two, named first and second, differential switching amplifier stages containing a first pair of transistors of PMOS type, the sources of which are connected together and to a supply voltage, one FET acting as diode the other as resistor biased FET switch; also containing a second pair of transistors of NMOS

type, differentially driven by said antiphased input signals, source connected together and to the drain of one commonly used transistor of NMOS type - the source of which is connecting to ground and the gate controlled by said externally supplied bias voltage - and whereby the drains of said second pair of FETs are serially connected to the drains of said first pair of FETs; further containing as booster amplifier a serial circuit of two transistors of PMOS type, source connecting the first FET to a supply voltage, the drain of the second FET connecting to ground and drain to source connected together and delivering thereby a resistor biased output signal;

one auxiliary transistor of NMOS type for delivering an internal supply voltage to said second differential switching amplifier stage;

one internal current source;

one output stage configured as serial circuit of two transistors of PMOS type and said internal current source, with first and second FET, drain to source connected together in a common node and the source of the said first FET connecting to circuit supply voltage, also said internal current source connecting to ground and connected in series with said two transistors and directly wired to the drain of the second FET, further configured with drain of said first FET and source of said second FET connecting to said common drain to source connection node where the internally generated driving signal is generated, whereas the internally generated sensing node signal comes from the connection node between the drain of said second FET and said internal current source;

two output terminal pins connected internally to the drains of said first and second FETs of said output stage and externally connecting respectively to gate and source of said external driven high-side electronic switch FET for said driving and sensing respectively, where said internally generated driving and sensing node signals stem from said respective connection nodes as described above.

22. A circuit, realizing a driver device for secure and reliable firing of an igniter or squib, connecting said squib via a high-side electronic switch to a power source and via a low-side electronic switch to circuit ground, incorporating separate power supply parts for high voltage and low voltage domains and equipped with intrinsic diagnostic and online testing features for circuit protection and operation securing purposes, comprising:

a control and test unit subdivided into a Firing Control (FC) part and a Diagnostic & Online Testing (DOT) part;

two output terminal pins for external connecting the igniter or squib to said circuit;

a first controllable electronic switch, named high-side switch, connecting to one side of said squib and allowing for connecting said squib to said power source;

a second controllable electronic switch, named low-side switch, connecting to the other side of said squib and allowing for connecting said squib to circuit ground;

one input connector pin for connecting an external mechanical safing sensor to said driver device fed by a charge pump which in turn is fed by said

power source, which itself is also connected and reverse battery protected by a series power diode and thus serving as main power input terminal and therefore connected to one side of said high-side switch;

one input connector pin for connecting an electronic safing sensor to said control and test unit of said driver device;

one output connector pin for a 'Fuel Cut-Off' signal generated within said Firing Control (FC) part of said control and test unit in case of a firing operation;

one output connector pin for a 'Diagnostic Lamp Driver' signal generated within said Diagnostic & Online Testing (DOT) part of said control and test unit in case of failure detection during normal operation of the circuit;

one first ground pin of the circuit wired to said low-side switch,

one second ground pin of the circuit wired to said first ground pin and to said control and test unit,

one controllable current source for driver switch diagnostics of said first controllable electronic switch, named high-side switch;

one controllable current source for said driver switch diagnostics of said second controllable electronic switch, named low-side switch;

one controllable current source for said driver switch firing of said second controllable electronic switch, named low-side switch;

one external power-supplying component receiving input from said separate power supply part of said low voltage domain;

one external power supplying component working as charge pump fed by said separate power supply part from said high voltage domain and feeding in

diagnostics mode said first controllable electronic switching device, named high-side switch in diagnostics mode and as well feeding an external energy storing device, realized as storage capacitor;

one High Side Driver (HSD) circuit block for driving said first controllable electronic switch, named high-side switch;

one external power supplying component working as charge pump fed by said separate power supply part from said high voltage domain and feeding said HSD circuit block;

two control signal lines fed by said control and test unit steering said controllable current source for said driver switch diagnostics and steering said controllable current source for said driver switch firing, both for said low-side switch; and

four sensing signal lines sensing the voltage levels on both sides of said two controllable electronic switches and feeding their signals into said control and test unit in both operating cases: diagnostic mode and firing mode.

23. The circuit, according to claim **22** wherein said first controllable electronic switch, named high-side switch is realized by an NMOS-FET switch and driven by said High-Side Driver (HSD) device.

24. The circuit according to claim **23** wherein said High Side Driver (HSD) device is realized as a monolithic integrated circuit.

25. The circuit according to claim **24** wherein said integrated High Side Driver (HSD) circuit comprises multiple FET transistors of NMOS type, multiple FET transistors of PMOS type, a digital inverter circuit for an input signal fed in from said control and test unit for control of said firing, diagnostic and online testing, a current source, and some additional integrated resistors, and whereby external connection pins are used by said input signal, and for connections to supply voltages and GND and for another two output connections for the internally generated driving and sensing node signals connecting to said high-side switch.

26. The circuit according to claim **25** wherein said High Side Driver (HSD) device is realized as a monolithic integrated circuit in CMOS technology.

27. The circuit according to claim **22** wherein second controllable electronic switch, named low-side switch is implemented by two low-side driver NMOS-FETs in current mirror configuration and thus serving as said low-side driver switch.

28. The circuit according to claim **22** whereby into said high-side switching device of said squib to said power source are combined together: firstly said switching transistor function for controlled firing operation and for onsite test diagnostics, secondly said controlled firing operation with current limitation and thirdly said onsite test diagnostics.

29. The circuit according to claim **22** whereby into said low-side switching device of said squib to said circuit ground are combined together: firstly said switching transistor function for controlled firing operation and for onsite test diagnostics, secondly said controlled firing operation with current limitation and thirdly said onsite test diagnostics.

30. The circuit, according to claim **22** implemented with said HSD controller for said driver switch firing of said high-side switch and with said controllable current source for said low-side switch, both trimmed i.e. setup in such a way, that the control currents for said switches are reduced to a safe minimum for a secure firing operation, thus allowing for the smallest external storage capacitor possible.

31. The circuit according to claim **22** implemented as integrated circuit.

32. The circuit according to claim **22** implemented as integrated circuit in low cost CMOS technology.

33. A method for controlled operation and secure firing of igniters or squibs, capable of driving the necessary switching devices within a circuit branch connecting said squib via a high-side electronic switch to a power source and via a low-side electronic switch to circuit ground, incorporating separate power supply parts for high voltage and low voltage domains and equipped with elaborate

intrinsic diagnostic and online testing features for circuit protection and operation securing purposes, altogether named Squib Driver circuit, comprising:

providing a means for a Control and Test Unit for said Squib Driver circuit, containing a Firing Control (FC) unit and a Diagnostic and Online Test (DOT) unit with input and output connections for - inter alia - an electrical Safing Sensor, a Fuel Cut-Off During Collision operation and a Diagnostic Lamp Driver signal, and further additionally containing measuring or sensing input signals and control output signals;

providing for said Squib Driver circuit means for connecting an external main power supply via a mechanical Safing Sensor and means for connecting to ground;

providing for said Squib Driver circuit external means for said power supply using a charge pump circuit for storing said main supply energy within an external storage capacitor as so called AVS voltage;

providing for said Squib Driver circuit connection means for connecting an external igniter device or squib to a first connection pin named high-side connection and to a second connection pin named low-side connection;

providing a first internal means for switching operations of said external igniter device or squib on its high-side connection point, named high-side switching device;

providing a second internal means for switching operations of said external igniter device or squib on its low-side connection point, named low-side switching device;

providing a first internal means for driving said internal high-side switching device, named High-Side Driver (HSD) circuit;

providing other internal means for supplying multiple driver currents to said internal low-side switching device using controllable and switchable current source circuits;

providing means for connection of said measuring or sensing input signals from said high-side and low-side switching devices to said Control and Test Unit;

providing means for connection of said control output signals from said Control and Test Unit to said controllable and switchable current source circuits for said low-side switching device;

implementing said high-side switching device as a single NMOS FET switch transistor;

implementing said low-side switching device with the help of a pair of NMOS transistors in current mirror configuration;

implementing said high-side switch driver circuit with the help of an integrated HSD circuit, consisting of two anti-phased driven current mirror differential switching amplifier NMOS&PMOS stages each with PMOS output booster circuit and both driving one PMOS output driver stage biased by an internal current source;

implementing for said low-side switching device said controlled pair of switchable current sources as drivers, whereby the one current source defines the normal diagnostic and test operations and the other current source the firing operation;

initiating a Basic Function Test Cycle for said Squib Driver circuit during power on of said Squib Driver circuit, testing regular functionality of said internal driver circuits and switches and said external igniter device or squib;

starting, in normal operation mode, the Diagnostic and Test Cycle for continuous surveillance of prescribed isolation and resistance values i.e. of the regular functioning of the system;

testing for isolation values of the high-side and low-side switching devices versus supply voltage and ground;

measuring appropriate test voltages at the squib and said high-side and low-side switching devices in the switched squib branch with the help of given diagnostic currents;

calculating the resistance of the squib and said high-side and low-side switching devices in the switched squib branch;

evaluating said measured and calculated values and compare to the prescribed and for a regular operation required and defined values;

activating in case of failure an alarming signal;

calculating with the help of said voltage and resistance values secure firing current values for said high-side and said low-side switching devices, thus trimming, i.e. setting-up said controlled driving currents to their operational necessary minimum, and thus limiting said main supply energy stored within said external storage capacitor to an optimum;

continuing the Diagnostic and Test Cycle from its starting point above during normal operation of the Squib Driver circuit; and

firing the squib in case of emergency by switching on at the same time, both the high-side and the low-side switching devices and whilst observing given current limitations with the help of said controlled driving currents.